P2LPC
Technical description

EAD 020.501.990

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P2LPC Documents:
- P2LPC_Technical_description
- P2LPC Configuration and setup
- P2LPC-ISAPIWS-webservice-2.10

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1 P2LPC data concentrator

P2LPC is data concentrator for automatic data collection from MT/ME351 and MT/ME371 MT/ME381 family system meters. Communication with the MT/ME3x1 system meter is made by means of the integrated PLC modem with DLMS/COSEM communication protocol. P2LPC is equipped with serial interface for reading RS485 system meters. P2LPC is based on multitasking operating system. Software application in P2LPC is responsible for reading, finding and managing communications with system meters over PLC network, storing data and transferring data to data collection centre on demand. For communication with data collecting centre P2LPC uses different communication possibilities – GSM, GPRS and Ethernet. Communication protocols used in communication with the centre are well known Internet protocols – PPP, TCP/IP, SNMP, FTP, WEB Services.

P2LPC is manufactured in conformity with the ISO 9001 standard.

1.1 Main characteristics

- Collecting data from system meters through the PLC modem network and/or RS 485.
- Data from meters are stored on persistent medium (Flash memory).
- Finding and managing system meters on PLC network.
- Multitasking operating system with embedded flash file system.
- Modem for communication with data collecting centre - GSM, GPRS and Ethernet.
- DLMS/COSEM communication protocol with system meters.
- Standard Internet protocols for communication with data collecting centre.

1.2 Documents

The aim of the PLC protocols used in IDIS is to allow a Client device (the concentrator) to communicate with the Server devices (the meters) by using the services defined by the COSEM or DLMS application layer on a PLC network infrastructure.

- The COSEM application layer is defined by the IEC 62056 series of standards and its extensions described in the DLMS UA Books
- The DLMS application layer and the lower layers of the PLC protocol are defined by the subset of the IEC 61334 standards.
- This communication objective also includes network management, using the services provided by the CIASE layer described in IEC 61334-4-511.

1.3 Standards

PLC communication and communication with data collecting centre comply with the following standards:

Physical layer – PLC

- IEC 61334-5-1 Distribution automation using distribution line carrier systems-Part 5-1 Lower layer profiles-The spread frequency shift keying (S-FSK) profile.
- EN50065-1 Signalling on low-voltage electrical installations in frequency range 3kHz to 148kHz-Part 1: General requirements, frequency bands and electromagnetic disturbances.

PLC networking

- IEC 61334-4-511 Data communication protocols - System management - CIASE protocol.

Communication between concentrator and system (variety of GSM and Internet standards defined in RFC)

- GSM/GPRS standards,
- LAN, Ethernet
- PPP,
- TCP/IP communication protocol
- Telnet, FTP, NTP, SNMP, HTML/XML/Web service.

2 P2LPC design

Figure 1: P2LPC

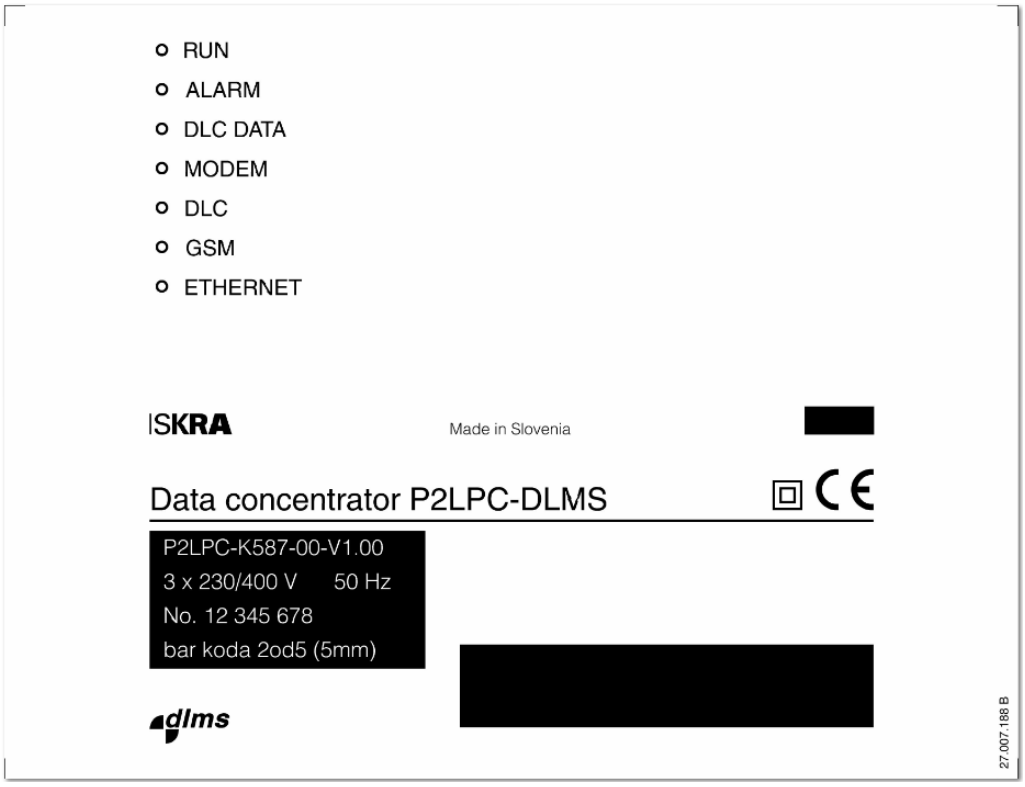

Figure 2: Front plate

Ordering code:

P2LPC	-	K587	-RS485 + ETHERNET + GSM/GPRS modem + PLC modem 2400 bps

2.1 P2LPC case

The P2LPC case dimensions comply with the DIN 43857 standard, parts 2 and 4. The P2LPC case protection degree against dust and water is IP 53. The case is made of incombustible polycarbonate that is environmentally friendly, as it can be recycled after the P2LPC concentrator lifetime has come to an end. The terminal block is integrated onto printed circuit board – main board. Clamps of massive brass are connected in it.

The case cover is made of transparent polycarbonate. The P2LPC and terminal block covers are separately fastened. Each of them is fixed with their sealing screws so that the P2LPC interior and the P2LPC terminal block are separately accessible by removing the seals and by unscrewing the screws. The sealing screws are safeguarded against falling off. The P2LPC hanger is a part of the case bottom.

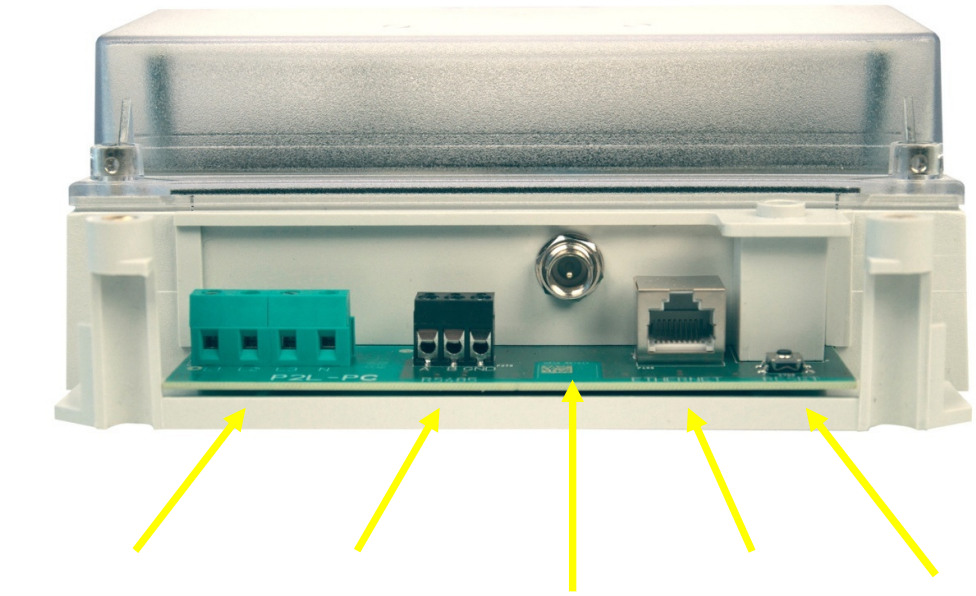

Figure 3 P2LPC terminal block (bottom view)

2.2 P2LPC dimensions

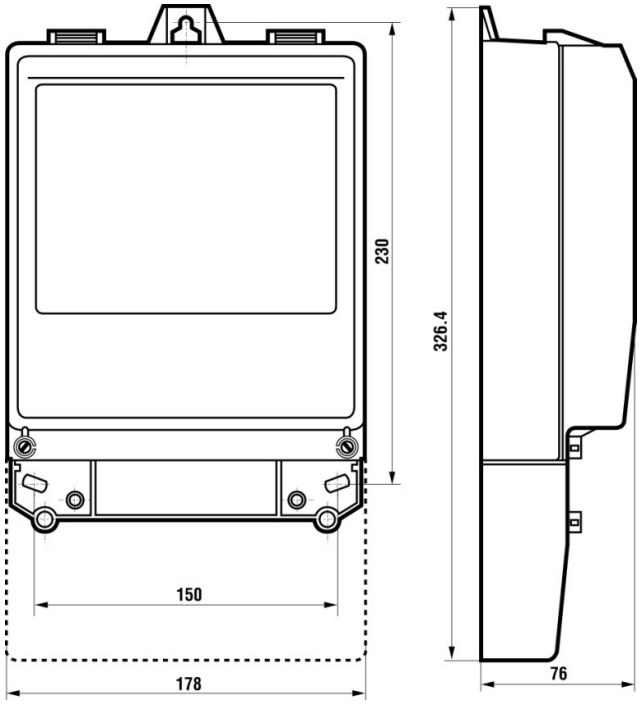

Figure 4: P2LPC dimensions

Dimensions	326.4 x 178 x 76 mm
Mass	Approx. 1.2 kg

3 P2LPC in AMI system

P2LPC is the central part of the AMI system. It collects data from system meters by means of two communications media; PLC or RS 485. Collected data from meters are stored inside P2LPC. Data collecting centre requests data from P2LPC. Communication with data collecting centre is performed via GSM public network or LAN (if LAN adapter is used).

The IDIS PLC system consists of:

- Single-phase and three-phase electricity meters with integrated PLC communication interface.
- Concentrators typically installed in the MV/LV transformer stations.
- The IDIS head end system managing the concentrators and the meters and providing the appropriate services to the MDM system.

Each of these "PLC modules" has a different communication profile. These profiles are as follows:

- The IDIS Server profile: integrated with the single-phase and three-phase electricity meters.
- The concentrator Client profile.

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- The concentrator Client profile.

In each Server profile, we distinguish between information which applies to the lower layers, Network management-related services and Meter application-related services. The following table summarises the services used by the Server profiles.

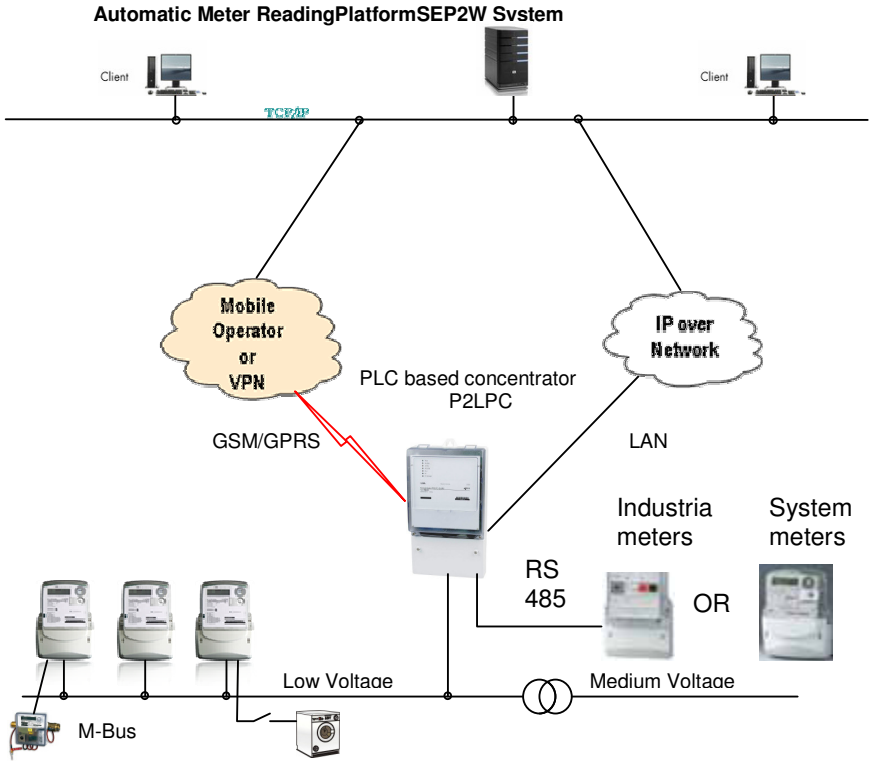

Figure 5: P2LPC used as PLC concentrator

4 P2LPC Hardware design

P2LPC consists of the following modules and components:

- Power supply
- Single board computer
- Main board
- Integrated PLC modem
- Modem module for communication with data collecting centre
- Serial RS485 communication port
- P2LPC case

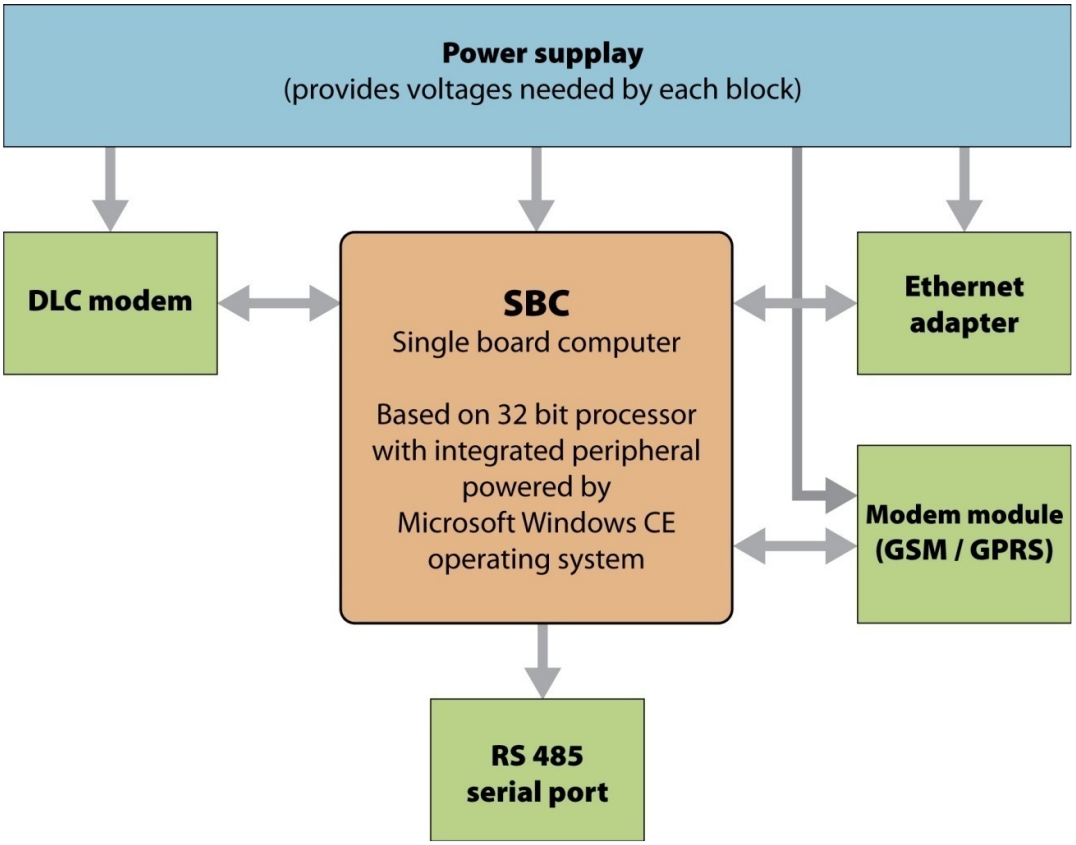

Figure 6: P2LPC block diagram

4.1 Power supply

It ensures the P2LPC concentrator reliable operation even if two phase voltages fail, and the grid voltage is in the range from 80% Un to 115% Un.

4.2 Single board computer (SBC)

P2LPC is based on a single board computer – SBC. SBC is based on 32-bit processor architecture, capable of running multitasking operating system. SBC is made in the form of module and has the following components:

- 32-bit CPU
- 32MB RAM
- Boot Flash
- Integrated Flash memory 64MB for loading operating system image and data storage

SBC has 3 serial UART interfaces for the following data communications:

- PLC modem
- Modem for communication with data collecting centre (GSM, GPRS)
- serial UART connector

4.3 Main board

A main board integrates all components of P2LPC. SBC is attached on the main board. Power supply, PLC modem and Ethernet controller are integrated on the main board. The main board is provided with connector for modem module for communication with data collecting centre. On the main board there is a terminal block for connection on low voltage side of the power transformer. There are also connectors for GSM antenna, external serial port and Ethernet connector.

4.4 Integrated PLC modem

The integrated PLC modem is built in the P2LPC main board, and enables data transmission through the communication interface to the system meters. Data transmission between the SBC and modem is serial asynchronous communication, with the rate 38400bit/s. The actual data transmission rate through the low voltage grid depends on current conditions in the grid. The modem is internally connected to the low voltage grid. The modem connection and synchronization on the mains frequency is realized on all three phases. PLC modem control software supports sending and receiving data on all three phases simultaneously or on each phase separately.

4.4.1 PLC communication part - Physical layer

The physical layer defines the method of transmission (type of modulation) used for transmitting information over the physical channel, i.e. the low-voltage electrical distribution network.

The type of modulation used is S-FSK (spread-frequency shift keying).
S-FSK modulation is a modulation/demodulation technique combining some of the advantages of a conventional spread-spectrum system (for example, jammer immunity) with those of a conventional FSK system (relatively non-complex, optimized implementation).

The physical layer conforms to the following standardization documents:

- CENELEC EN 50065-1/A1, which defines the transmission bands and the rules, in order to limit mutual influence between signal transmission equipment in electrical installations and between such equipment and other equipment.
- IEC 61334-5-1 which defines the rules and the performances expected from an S-FSK modulator/demodulator.

PLC (distribution line communication) is communication that is running over existing low voltage grid. The structure of communication is basically such that a primary station (data concentrator) is connected in/on transformer station; secondary nodes (meters) are installed at measuring points, at household premises. Due to the nature of power grid, our solution of PLC communication is in accordance with Cenelec standard EN 50065-X that in several ways restricts and prevents big influence of communication on environment.

Some basic characteristics of used communications are:

4.4.1.1 Type of modulation

The modulator/demodulator characteristics are as follows:

- Modulation: S-FSK (Spread-Frequency Shift Keying).
- Communication frequencies:

  Fm (Mark frequency - Mark): 63.3kHz

  - Fs: (Space frequency - Space): 74kHz
- Modulation rate: 2400 Baud - 1200bps over grid (under certain conditions 300bps possible) V2.

- Physical synchronization with the 50Hz electrical network frequency.

4.4.1.2 The level of injected signal

The level of injected signal is in compliance with standard EN 50065 – Signalling on low-voltage electrical installation in the frequency range 3kHz to 148kHz.

4.4.1.3 Type of coupling

Capacitive, isolated with transformer galvanical insulation.

4.4.1.4 Type of communication

Two-way, half-duplex.

4.4.1.5 Communication structure

Master (data concentrator) – Slave (meter)
Modes of operation: Polling, broadcast
Repeater mode - Self-adaptive, based on Signal/Noise measurement of both sub-carriers
Auto logging of nodes: Yes
Power consumption (PLC part) - On EN50065 artificial measuring test setup 300 mA / 5 V

4.5 WAN Modem Module

A modem module is used for communication with data collecting centre. Types of modem modules connected to the port on the main board are possible:

- GSM/GPRS modem

4.5.1 Technical data for GSM modem module

Product features:

- Dual-band EGSM900 and GSM1800,
- Compliant to GSM phase 2/2+,
- Output power:
  - Class 4 (2W) at EGSM900,
  - Class 1 (1W) at GSM1800,
- Control via AT commands,

Data:

- CSD up to 14,4kbps,
- Non transparent mode,
- V.110.

Interface:

- SIM 1,8/3V,
- RS232 bi-directional bus,
- Autobauding,
- FME antenna connector.

Control circuit:
Observe status of GSM module. In the case that the modem is not registered, it will periodically shut down power supply. When unregistered status is detected for the first time, it waits up to 48s, every next up to 22s before it shuts down power supply for 4s.

4.6 RS485 Serial communication port

P2LPC is equipped with RS485 serial interface placed under terminal cover. This serial port can be used for connecting meters with RS485 communication port.

This interface can be used for three functions excluding each other:

1. Access and supervision of the concentrator. Telnet commands on RS485 serial interface (system default setting).
2. Reading of the meters attached to RS485 serial interface from main application using COSEM/DLMS protocol (Mx372-RS meters)
3. Reading of the meters attached to RS485 serial interface using Consereth application and protocol

Note: these functions exclude each other. Only one can be used at the time. Which function will be used have to be defined by

concentrator ordering and can be changed later.

5 P2LPC functionality

P2LPC functionality is based on multitasking operating system. P2LPC application is running on Windows CE operating system, which performs all functionality of P2LPC. P2LPC application is multithreading application. Multiple threads run simultaneously, each of them responsible for different functionality of P2LPC.

Functionalities can be divided in the following parts:

- PLC networking: CIASE protocol with alarm handling [9],
- Meter readout,
- Meter configuration and control,
- Data storage,
- Communication with data collecting centre.

5.1 Configuration of PLC network - PLC networking

The discover and registration of the new PLC meters modules are performed by using standard IDIS CIASE services [9].

5.1.1 Finding and installing new meters in PLC network

The concentrator periodically or when PLC alarm is pending starts the CIASE discover service to discover and register the new PLC meters or PLC meters with alarms. New PLC meters or meters with alarm responds to discover request. For each new PLC meter, unique PLC physical address (MAC address) is assigned and sends back to meter as CIASE register service. Meter is added to internal list to be read by schedule. For PLC meters which are already in list, existing MAC addresses are reassigned. PLC meters with alarm pending are put in special list for alarm readout. Meters with alarms are read during readout process, which is started after CIASE discover service is finished.

Note: CIASE discover service triggered by PLC physical alarm if is configured.

5.1.2 De-install of meters in PLC network

PLC meters not responding to requests after certain number of attempts or time are removed from read list. PLC meters not addressed by PLC network master (concentrator), unregisters automatically from network after specified time ("Time out not addressed"). These meters became ready for PLC master to be rediscovered and registered to same or different PLC master. If the same concentrator discovers it again, it will assign it the same MAC address.

Note: explicit deinstall can be executed by CIASE ping service with special parameters. It is not used in P2LPC application currently. It could be requested from IS.

5.1.3 Checking meters in PLC network – ping

Checking of installed meters is a periodical process performed by P2LPC. By checking we can adopt PLC communication parameters to conditions on grid. For each meter installed, P2LPC send ping-request message with specifying a system title as a parameter for particular meter. If a slave device receives that request, it responds with ping-respond message with its system title. If a master (P2LPC) receives response, PLC parameters are updated for this slave and next slave from the list is processed. If request is not received by the slave (meter) or response from the slave is not received by the master in specified time, new request from the master will be sent. With new request PLC modem parameters are changed and timeout is longer. This is repeated several times with different PLC modem parameters and timeouts. If the slave does not respond on requests or the slave responses are not received by the master, this slave is marked as “lost” and is not read when readout process is performed.

5.2 Meter readout

Meter readout is the most important operation of P2LPC. Readout is a periodic task, which is executed by time schedule. Time schedule period is a system parameter

and can be set. Typical readout period is between 5 to 60 minutes. All meters, which are registered in PLC network, are read. Results are stored into data base. Each meter has its data base file. For meter reading a COSEM/DLMS communication protocol stack is used. Simplified OSI model communication stack is used as defined in standards IEC 62056 – 46 (Data link layer using HPLC-protocol) and IEC 62056 – 52. On physical layer P2LPC uses a PLC modem. Special software driver is used for sending and receiving data to PLC modem, making PLC modem transparent for upper communications layers. COSEM/DLMS uses LLC IEC 61334-4-32 frames for data link layer.

5.2.1 Layered structure of communication stack

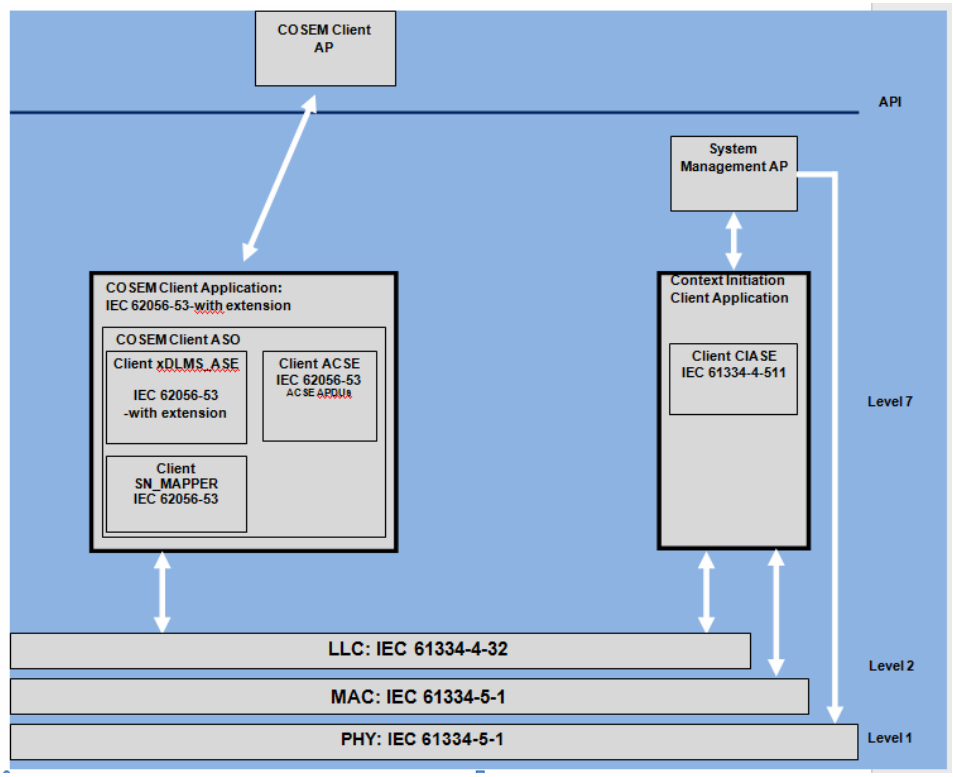

Figure 7: Layered structure of communication stack

5.3 Meter configuration and control

Meter configuration and control are performed by P2LPC. Examples of configuration and control are changes in tariff rules, new activity calendar or new special days calendar. DLMS/COSEM communication protocol is used for sending special objects to configure and control meters. P2LPC receives new configuration data from data collecting centre in form of file. This file is then translated into COSEM objects and distributed to the meters over PLC network.

5.4 Data storage

Meters data, status and configuration are stored in database file. Common database holds information specific to particular meter like PLC settings, profile configuration, access passwords, scalars and unit, last readout times etc. DC needs to retrieve constant meter data like scaler and unit at

first readout of the meter and stores them in common database. By this the performance is increased not to read constant data from meter each time when meter is read. DB provides persistent storage for meters data and configuration, DC meters list and meters configuration and results.
New service configurations are provided by xml configuration files and stored into DB trough service itself.

All needed data are stored in database. Database is divided in two major parts.

Information used for the concentrator use:

- List of installed devices (common):
  - Names,
  - Communication parameters,
- Reading schedules,
- Events.

Meter data (one file per meter):

- Measuring results,
- Format of the registers.

All the data are stored as COSEM objects.

5.5 Communication with data collecting centre

Communication with data collecting centre is possible by a GSM/GPRS modem module or Ethernet LAN connection. When the modem module is used for communication Microsoft Windows CE uses Remote Access Server – RAS. RAS uses PPP (RFC 1661) to establish and maintain peer-to-peer connection with data communication centre. If P2LPC is configured to connect to GPRS network, P2LPC establish connection to GPRS network and maintain this connection (redial/configure if it is lost). In this configuration P2LPC acts like client (opposite to RAS, where acts like server). On a transport layer a TCP/IP stack is used. On the upper layer of TCP/IP stack, Windows socket interface is exposed to applications. These applications are FTP server for transfer of meters readout files, WebService for transfer of meters readout data and manage the AMI system, SNMP for management and NTP for time functions. All this applications are standard Internet applications defined in many RFCs. On the data collecting centre side, data are received by SEP2W System application and stored into database for further processing.

5.6 WEB User interface

User interface is reachable by software application running on P2LPC and started from on the P2LPC connected computer. The procedure for running user interface can be found in the User Manual.
There is some information such as:

- List of installed meters,
- Data transactions,
- Readout schedule,
- Running thread operations.

From a Command menu some threads action can force. These actions are:

- Finding new meters,
- De-installing meters,
- Forking meters,
- Force reading schedule.

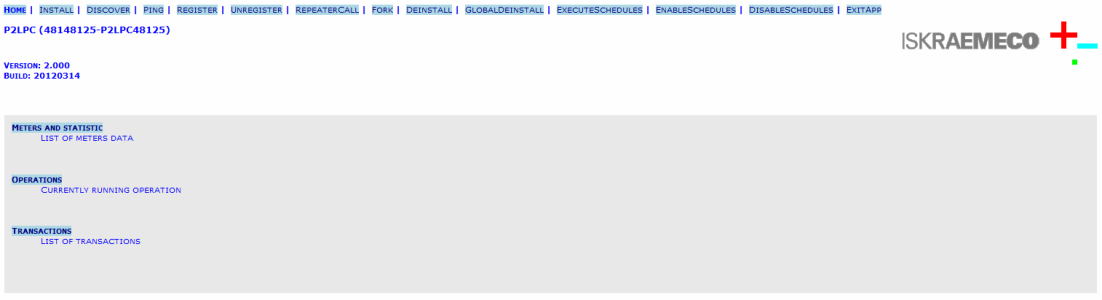

Figure 6: Web GUI default page

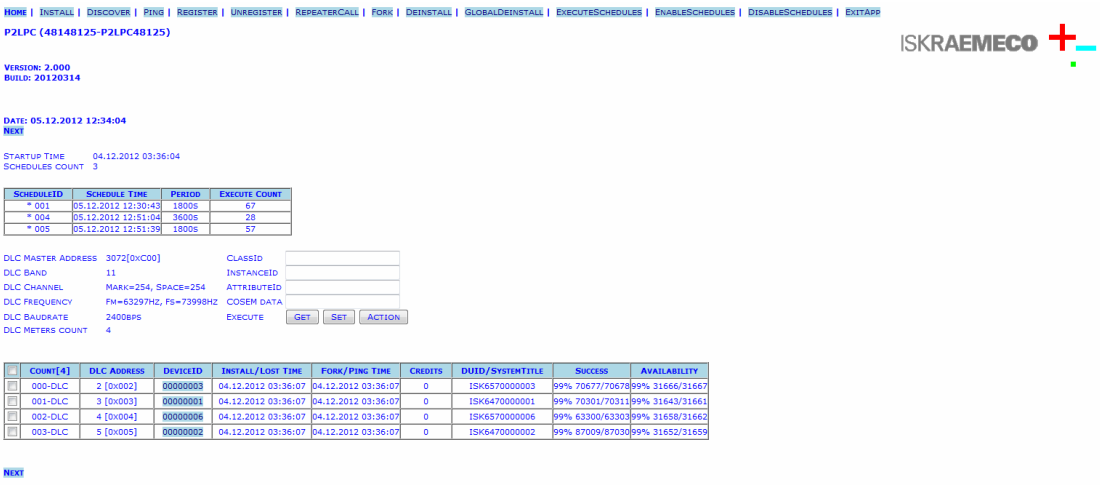

Figure 9: Web GUI meters list

Figure 10: Web GUI operations

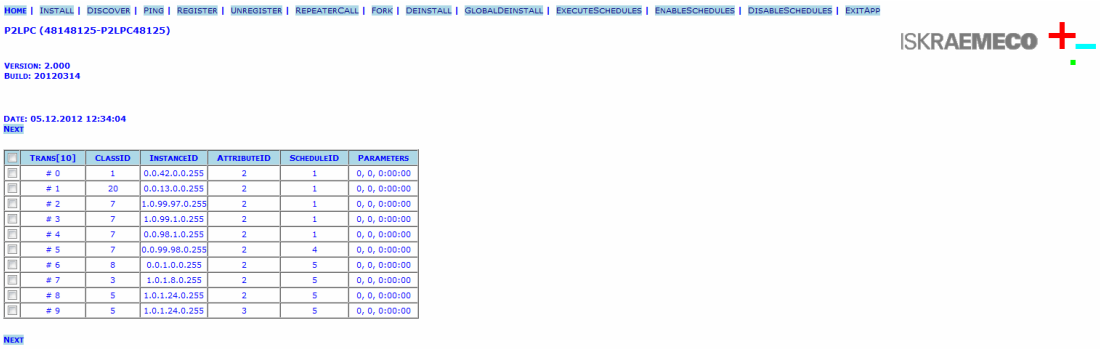

Figure 11: Web GUI readout transactions

5.7 Configuration

Some parameters are stored in P2LPC.xml file, which is read when P2LPC application starts. P2LPC.xml can be changed while P2LPC application is running and then reload. Here is an example of P2LPC.xml file:

```
<P2LPC>
        <Info  Version="1.00" Producer="ISKRAEMECO d.d." />

        <Device ID="00000000" LogTraceLevel="1" />

        <PhysicalLayer UsePLC="1" PortName="\\.\COM10" />

        <Readout SchedulePeriod="900" />

        <Schedules>
                <Schedule Ident="2" Period="3600" />
        </Schedules>

        <PLC
                UseAllRST="1"
                MasterAddress="1100"
                FindTimePeriod="900"
                ForkTimePeriod="3600"
                DeinstallTimePeriod="0"
                AutoDeinstallTimePeriod="43200"
                EnableTimeSync="0"
                FindSlavesCount="2"
                FreqBand="0"
                Gain="6"
        />

        <RAS
                StartTime="00:05:00"
                Period="86400"
                RemoteDirectory="\\\\REMOTE_COMPUTER\\RAS_TEST"
                PhoneNumber="123456" AreaCode="4"
                CountryCode="386"
                Mode="GPRS"
        />

        <RF PortName="\\.\COM6" />

        <Transactions>
          <Transaction Type="get" ClassId="3" AttributeId="2" InstanceId="1.0.5.4.0.255" />
        </Transactions>
</P2LPC>
```

5.7.1 Logging and statistics

Statistic and logging are also a part of user interface. Operations performed by P2LPC application threads are logged into P2LPCLog.txt file. This file can be open to track thread execution. P2LPC log has three types of logged information – error, warning and information. Statistic of success on PLC network is also recorded by P2LPC application into P2LPCStat.txt file. In this file you can see how many meters are installed into P2LPC, time when meters were installed, forked (ping) or lost from PLC network. You can also see quality of data transfer over PLC modem and availability of meter to P2LPC on PLC network.

For more information about files read “P2LPC File formats” and “P2LPC Users manual” documents.

6 Technical data of P2LPC

6.1 General features of P2LPC

Nominal voltage	U_n	3x230/400 V, 3x400 V other voltages on request
Voltage range		0.8 U_n ... 1.15 U_n
Nominal frequency	f_n	50 Hz or 60 Hz
Operation temperature		-20 °C ... +60 °C
Storage temperature		-40 °C ... +80 °C
Power consumption		25 W max

6.1.1 PLC communication interface

Communication protocol		LLC IEC 61334-4-32
Data transmission rate		2400 bit/sec

6.1.2 Real time clock backup

Real time clock backup time (active only during power off state of data concentrator)		Minimum 10 years
Real time clock backup device		Lithium Battery

6.1.3 RS485 communication interface

Physical Driver		Up to 255 devices
Data transmission rate		300 - 38400 bit/sec

6.2 P2LPC resistance to electromagnetic interferences

Insulation strength	4kV, 50Hz, 1min
Electrostatic discharge	15kV (IEC 61000 - 4 - 2)
Electromagnetic field	10V/m (IEC 61000 - 4 - 3)
Burst test – high-frequency interferences	4kV (IEC 61000 - 4 - 4)
Impulse voltage test	12kV, 1.2/50µs (IEC 62052-11 or EN 50470-1) - into the P2LPC main circuit
Surge voltage test	6kV, 1.2/50µs (IEC 62052-11 or EN 50470-1) - into the main circuit

Reference list:

1. IEC 62056 – 46 Data Link Layer using HPLC-Protocol,
2. IEC 62056 – 53 COSEM Application Layer,
3. IEC 62056 – 61 OBIS Object Identification System,
4. IEC 62056 – 62 COSEM Interface Objects,
5. IEC 61334-4-1:1996, Distribution automation using distribution line carrier systems – Part 4: Data communication protocols - Section 1: Reference model of the communication system,
6. IEC 61334-4-32:1996, Distribution automation using distribution line carrier systems – Part 4: Data communication protocols - Section 32: Data link layer - Logical link control (LLC),
7. IEC 61334-4-41:1996, Distribution automation using distribution line carrier systems – Part 4: Data communication protocols - Section 41: Application protocols - Distribution line message specification),
8. IEC 61334-4-42:1996, Distribution automation using distribution line carrier systems – Part 4: Data communication protocols - Section 42: Application protocols - Application layer,
9. IEC 61334-4-511:2000, Distribution automation using distribution line carrier systems – Part 4-511: Data communication protocols - Systems management - CIASE protocol,
10. IEC 61334-4-512:2000, Distribution automation using distribution line carrier systems – Part 4-511: Data communication protocols – Systems management – Management Information Base (MIB),
11. IEC 61334-5-1:2001, Distribution automation using distribution line carrier systems – Part 5-1: Lower layer profiles - The spread-frequency shift keying (S-FSK) profile,
12. IEC 62056-53 Ed.2:200X, Electricity metering – Data exchange for meter reading, tariff and load control – Part 53: COSEM Application layer,
13. IEC 62056-61 Ed.2:200X, Electricity metering – Data exchange for meter reading, tariff and load control – Part 61: OBIS Object identification system,
14. IEC 62056-62:200X Ed.2, Electricity metering – Data exchange for meter reading, tariff and load control – Part 62: Interface objects,
15. IEC 61334-6:2000, Distribution automation using distribution line carrier systems – Part 6: A-XDR encoding rules,
16. CENELEC EN50065-1/A1 May 2002 Signalling on low-voltage electrical installation in the frequency range 3 kHz to 148 kHz. Part 1: General requirements, frequency bands and electromagnetic disturbances,
17. COSEM Identification System and Interface Classes (Blue Book) DLMS UA 1000-1:2009 9th edition,
18. DLMS/COSEM Architecture and Protocols (Green Book) DLMS UA 1000-2:2009 7th edition,
19. IEC EN50065-7 Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz. Equipment impedance.

Due to periodical improvements, actually supplied products may differ in some details from data stated in the technical description.

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